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ABSTRACT

This paper explores how organizational features of high schools influence the informal interaction of students attending them. Size of school, composition of the student body, and differentiation into curriculum and grade levels are factors which affect the patterns of informal interaction among students. The informal social arrangement of students within schools is viewed as a social network in which the friendship and esteem relationships are particular ties. Properties of social networks (reachability, cohesion and participation) are defined, and actual measurements of 40 social networks are derived and studied in connection with specific organizational properties of the school. (Author)

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SCHOOL INFLUENCES ON STUDENT INTERACTION PATTERNS

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Introductory Statement

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through three programs to achieve its objectives. The Schools and Maturity program is studying the effects of school, family, and peer group experiences on the development of attitudes consistent with psychosocial maturity. The objectives are to formulate, assess, and research important educational goals other than traditional academic achievement. The program has developed the Psychosocial Maturity (PSM) Inventory for the assessment of adolescent social, individual, and interpersonal adequacy. The School Organization program investigates the authority-control structures, task structures, reward systems, and peer group processes in schools. It has produced a large scale study of the effects of open schools on students, has developed the Teams-Games-Tournament (TGT) instructional process for teaching various subjects in elementary and secondary schools, and has produced a computerized system for school-wide attendance monitoring. The School Process and Career Development program is studying transitions from high school to post-secondary institutions and the role of schooling in the development of career plans and the actualization of labor market outcomes.

This report, prepared by the School Organization program, investigates how the interaction and friendship relationships of students are influenced by organizational features of high schools.

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Abstract

This paper explores how organizational features of high schools influence the informal interaction of students attending them. Size of school, composition of the student body, and differentiation into curriculum and grade levels are factors which affect the patterns of informal interaction among students. The informal social arrangement of students within schools is viewed as a social network in which the friendship and esteem relationships are particular ties. Properties of social networks (reachability, cohesion and participation) are defined, and actual measurements of forty social networks are derived and studied in connection with specific organizational properties of the school.

Introduction

Peer influences are prominent factors in most discussions of the educational aspiration formation process (Coleman, 1961; Duncan, Haller and Portes, 1968; Alexander and Eckland, 1975; McDill and Rigsby, 1973). The view that peers influence one another's aspirations is based, in part, on the observed similarity in educational aspirations among adolescent friends which has been consistently documented (Simpson, 1962; Krauss, 1964; Duncan, Haller and Portes, 1968; Alexander and Campbell, 1964; Campbell and Alexander, 1965; Kandel and Lesser, 1969; Pavalko and Bishop, 1966). Because most studies rely upon cross-sectional data, it is usually not clear to what extent this similarity reflects "selection" or "influence" processes. One procedure for analyzing such cross-sectional data entails posing a model in which the selection factors appear as exogenous variables before the "net" mutual effects on educational aspirations are assessed (Duncan, Haller and Portes, 1968; Picou and Carter, 1976). The efficacy of the interpretation of the observed effect as an influence is thus highly contingent upon the extent to which selection factors have been adequately considered.

Typically, properties of the school setting are not considered as selection factors influencing the pattern of peer associations. For example, such characteristics as curriculum and grade level greatly alter the opportunity for contact among students, yet these factors

are not incorporated in peer influence models. If all schools were organized identically, omission of these factors would not be a serious problem, but schools do differ in size, differentiation of students into grade and curriculum, and composition of the student body.

This paper explores how these characteristics of schools influence the interaction patterns of students. Because the interaction of peers is important in educational aspiration formation, an adequate model of the aspiration process should pay attention to factors affecting the interaction patterns. Specific features of schools can greatly influence which students come into contact with which other students. Thus, particular organizational aspects of the school may be important indirect factors in the peer influence process.

The paper first discusses the nature of organizational characteristics of schools--school size, differentiation into curriculum and grade level, and school composition. Second, the conceptualization and measurement of interaction patterns are discussed. The next section details the methodology, and the last section reports a study of the relationship between school organizational features and student interaction patterns. In this analysis, the McDill twenty high school data, collected in 1964-5 by E. L. McDill and his colleagues, is used. Details of the sample design and the survey instrument may be found elsewhere (McDill and Rigsby, 1973). A description of the variables used in this investigation is provided in Appendix A.

Features of School Organization

School Size

Size and its effect on the internal structure of groups has been of traditional concern to sociologists (Wirth, 1938; Durkheim, 1933). Recently, consistent findings of size effects in quite diverse settings (Kasarda, 1974) has suggested the utility of explicitly considering the effects of size in sociological inquiry. Mayhew and Levinger (1976) propose that the potential density of interaction increases multiplicatively with group size, and they discuss the implications of this relationship for a variety of social phenomena including rates of violence, communication patterns, and the nature of urban social relations. In their framework, size affects interaction patterns through the multiplicatively increasing opportunity for contact among group members. Yet, the multiplicative nature of the size-interaction relationship is constrained because interactions among individuals requires time and energy, which is finite. Thus the average amount of time per contact decreases with increasing size. Therefore, anonymity is predicted to be positively related to aggregate size.

Studies considering effects of school size have examined several outcome measures with inconclusive results. Conant (1959) suggested that larger, comprehensive high schools would produce greater opportunities to tailor programs to the individual talents of students; however, Conant did not empirically support this position. Barker

and Gump (1964) studied 13 Kansas high schools of size 35 to 2300 and found that, in contrast to Conant's thesis, students in smaller, not larger, schools participated more often and to a greater extent in a wider variety of the "behavior settings" available to them.

Research on effects of school size on student interaction patterns does find consistent and meaningful effects. McPartland and McDill (1976) found a positive effect of school size on deviant behavior of students in the school setting. They explain this finding in part by the greater anonymity afforded students in larger schools. Coleman (1961), analyzing the peer structure of ten high schools, found that in the smaller schools a larger percentage of students were clique members than in the larger schools where they were likely to be involved in simple pair relationships. Coleman also found that the psychological effects of being a social isolate, that is, someone not nominated as a friend by anyone in the school, were more detrimental in the small schools than large schools.

Other studies have focused on the relationship of classroom and achievement outcomes. The several studies reviewed by Boocock (1966) suggest inconclusive evidence for classroom size effects. However, the variation in classroom size in most instances is quite restricted.

Sorting of students by curriculum and grade level

The differentiation of students into various curricula and the classification of students by grade level affects their physical proximity and consequently their opportunities for interaction with particular other students.

Grade-level

A pronounced tendency for friendship groups to cluster according to grade-level has been documented (Coleman, 1961; Gordon, 1957; Karweit, 1976). For example, in the sociograms presented by Coleman (1961: 175-182), some 89 percent of the reciprocated choices were made within-grade. Gordon (1957), studying the peer structure of a single high school, found that 84 percent of the friendship choices were same grade/sex choices. He also noted that the structures differed by grade, primarily reflecting the effects of clique membership. Karweit's (1976) analysis of the friendship structure in twenty high schools showed that 85 percent of the girls and 76 percent of the boys chose their first friend within grade.

Curriculum

Recently, the effects of differentiating students by curricula have become of special interest. For example, it is claimed that resources within schools are differentially dispensed on the basis of curriculum. In this context, school resources are construed as the human and material elements of a school which can influence achievement or other outcomes. These resources may be access to counselors (Heyns, 1974), to highly motivated peers (Alexander and McDill, 1976; Karweit, 1976), or to specific socialization processes (Rosenbaum, 1975).

Heyns, studying the effect of curriculum placement on access to and utilization of counselors within schools, documented significant effects attributable to curriculum enrollment. Using the Equality of Educational Opportunity Survey data (EEOR) (Coleman, et al, 1966)

for the twelfth and ninth grades, Heyns found significant effects of curriculum placement on amount of encouragement and number of visits to a counselor after controlling for verbal ability, father's education, father's occupation and number of siblings. Heyns concludes that curriculum enrollment influences the differential allocation of resources within schools.

The theme that curriculum placement differentially affects the experiences of high school students was explored by Alexander and McDill (1976) using a subset of the McDill Twenty High School Data. They posed a model of curriculum effects in which socioeconomic characteristics and ability influenced curriculum placement which subsequently directly influenced rank in class, achievement scores and one's peer associates. These curriculum effects were shown to have direct and indirect consequences for such subjective outcomes as educational aspirations, academic self concept and orientation toward intellectualism. Alexander and McDill argue that curriculum placement affects peer associates and in particular that college preparatory program placement provides access to academically motivated peers. They conclude:

> "Thus, the non-random distribution of students to tracks appears to circumscribe a pool of potential associates such that college preparatory students are more likely to establish close ties with peers whose competencies and interests are consonant with the formal educational objectives of the school. In view of the well-documented importance of peer networks and of the quality and character of one's associates for subsequent school outcomes, this may be a quite consequential effect of curriculum differentiation." (Alexander and McDill, 1976: 19).

Rosenbaum (1975) focuses on another aspect of the effects of curriculum placement. Studying the effects of a tracking system in a single high school, he suggests that non-college preparatory and

college preparatory tracks present very different socialization environments. In the college preparatory track, the environment stresses differentiation--students are urged to express their different interests and backgrounds, and the emphasis is on self-direction. In contrast, according to Rosenbaum, the non-college preparatory students are presented with a homogenizing setting, which stresses conformity and compliance.

The analyses of Heyns, Alexander and McDill, and Rosenbaum focus on outcome variables and school process variables which are typically ignored in the voluminous and basically inconclusive studies of tracking. Jencks (1972), reviewing these studies and summarizing an analysis of his own, concludes that tracking and curriculum differentiation are of little consequence for cognitive outcomes. Yet, for understanding the long term effects of schooling on achievements and orientations, the curriculum effects on such subjective orientations as considered by Alexander and McDill (1976) and Rosenbaum (1975) may be significant indeed. In fact, ignoring such effects may contribute substantially to our limited understanding of the education-work linkages and the unsatisfactory conclusion that occupational outcomes are predominantly determined by chance factors (Jencks, 1972).

Student Body Composition

The academic impact of differences in the racial or socioeconomic composition of the school has been of considerable research interest

(Wilson, 1959; Michael, 1961; Sewell and Armer, 1966: Coleman et al, 1966; McDill and Rigsby, 1973). For the most part, this research has compared composition differences across schools and assessed their influence in differences in academic achievements and orientations among schools [but see McPartland (1968)]. The level of analysis in the present paper thus contrasts with most studies of composition effects. We are concerned with how the interaction patterns within schools are influenced by the composition of the school.

For this investigation, we are concerned with composition effects on the informal social structure of the school. Do more diverse student bodies foster friendships and peer contacts among a diverse set of individuals or, conversely do more diverse settings create "barriers" so that peer contacts are more homogeneously drawn? We consider the relationship between student body composition and cohesiveness or divisiveness of the school an important, but overlooked, consequence of differing racial or socioeconomic school compositions.

Interaction Patterns within Schools

The use of sociometric techniques to describe the pattern of interaction among students has been a long and continuing tradition in social psychology. Any sociometric analysis describes how a set of individuals is linked together by some relationship. Sociometry takes

a single relationship, maps the corresponding ties among individuals and examines the resultant structure independently of other relationships.

Social network theory, which can be seen as a logical outgrowth of sociometry, differs in several ways. The network perspective examines the multiple relationships of individuals ("multiplexity"), that is, the overlapping of the various informal, formal and situational ties which link individuals together. Also, as Schutte and Light (1976) point out, social network theory is not confined to studying structures emerging from informal associations but can be (and has been) applied to quite diverse settings. In summary, the network approach attempts to map multiple relationships among individuals to provide an adequate picture of the social structure. These relationships may be informal, such as affective ties, or may be formal or situational. The specific aim is to explore the interdependencies among the various networks and the resultant structure.

This perspective offers several advantages for studying how school organizational features affect interaction patterns. Specifically, it becomes possible to map the overlapping relationships which occur within a school into convenient indices which can then be studied in relation to school organization features. Additionally, the perspective encourages the exploration of the relationship among various networks. For example, the practice of sorting students into grade levels and tracks results in a proximity network in which same grade and same curriculum students are clustered. In turn, the

friendship network (as a dependent variable) is heavily influenced by the shape of this proximity network.

Contents of Networks: Proximity, Friendship and Esteem

We will examine three types of networks: proximity, friendship and esteem. Proximity is seen as a prominent factor in determining who comes into contact with whom and thus provides the opportunity for establishing friendship or other peer relationships (Festinger, et al, 1950; Homans, 1950). Normally, proximity is suggested by spatial closeness, such as same neighborhood or same workplace. In this study, proximity is suggested by those features of schools which sort students into groups for significant portions of the school day so that most interaction takes place within these groups, namely the differentiation of students by grade level and curriculum. Because most classes and home rooms in high schools contain same-grade students, grade in school determines to a large degree the "social neighborhood" of a student, i.e. it operates as a proximity filter (Duck, 1973). Curriculum placement likely operates in much the same way with its effectiveness as a sorting device depending upon the rigidity of the tracking system.

In models of the aspiratic process, friendship associations are typically considered as a specific peer relationship through which educational aspirations are influenced. Although it is likely that adolescent friends comprise an important influence source if for no other reason than the amount of time friends spend together, peer

relationships other than friendship may be important in setting aspirations. Specifically, students may come to fashion themselves after someone they particularly admire or wish to be like, but with whom they are not friends. Consequently, for understanding the influence of significant other peers on aspirations, we will consider both friendship and esteem networks, and the particular school context in which they occur.

School Organization and Characteristics of Networks: Some Proposals

Specific ways will be investigated in which friendship, esteem, and proximity networks are shaped by particular characteristics of schools--their size, their differentiation practices and their student body composition. We will be interested in how school characteristics influence the individual networks and how they influence the overlapping of the various networks. Three specific propositions will be considered.

1. Size of school is inversely related to network participation and cohesion.

This first hypothesis suggests that the size of the school will influence both the quantity and quality of involvement in peer relationships within schools. School size is proposed to have a negative effect on participation primarily through increasing opportunities for contact and increasing anonymity of individual students. We expect that a greater proportion of students in larger schools will sense that they are unimportant in the life of the school, that is,

they are less visible or noticeable in larger schools than in smaller ones. This sense of not being attached as strongly to the school will have effects on participation in a wide range of areas. In terms of specific networks and participation, we expect to find that increasing school size will decrease the involvement in friendship and esteem networks and increase the involvement in proximity networks.

School size is also predicted to inversely affect the cohesion of the networks. We propose that as school size increases, the reciprocation of friendship choices decreases, the consensus on esteem choices decreases, and the reciprocation of within-grade or curriculum choices increases.

2. Differentiation practices create proximity networks which influence the friendship and esteem networks.

The sorting of students by grade level and by curriculum means that some segments of the student body are more likely to be in contact than are others. When students lack the opportunity to interact with certain other students, it is unlikely that friendship or other peer associations can result. Thus, peer relationships are more likely to be formed between same curriculum and same grade-level students.

2a. The rigidity of the differentiation system will influence the extent to which interaction occurs within grade level or curriculum.

Schools are probably not identical in the extent to which students select same or different peers as associates; this proposition suggests that the variation will be related to the differing opportunities in

the school setting for contact with different peers. In particular, the nature of the tracking system is hypothesized to influence the extent of within-curriculum choices.

3. Heterogeneity of the student body will influence the shape and content of the friendship and esteem networks.

Ideally, a school with students who vary in ethnic and socioeconomic backgrounds should provide opportunities for students to interact with one another and for friendship and other peer relationships to develop among peers of different backgrounds. Yet, the practice of tracking students and the dependency of curriculum placement on ability and/or on social class origins may prevent these interactions, and students in heterogeneous schools will form friendships with peers very much like themselves.

The existence of varied types of students within the school may, in itself, accentuate rather than blur social background differences, thus promoting division of the school into separate, cohesive groupings. However, although salutary effects of heterogeneous schools may not come about through the friendship process, the schools do provide a more varied set of reference individuals, which could influence the esteem network. Thus ethnically and socioeconomically different children may not become the best of friends, but going to school together may at least provide exposure to and perhaps emulation of a more varied set of individuals.

Network Measures

Data and Measures

The McDill Twenty High School Data will be used in this analysis. Variables to be used are described in detail in Appendix A; details of the study, sample design and results of the initial study are provided elsewhere (McDill and Rigsby, 1973). A discussion of measurement error in sociometry, especially as it relates to the items used here is also given in Appendix A.

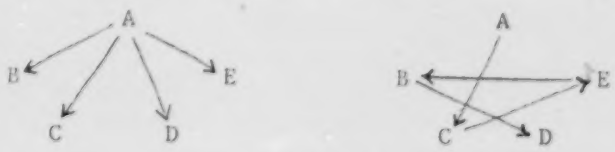
We will use two sociometric items from the original study: (1) friendship choices (same-sex and within-school) and (2) admiration or esteem choices (within-school). From these items, friendship and esteem networks were obtained for each school-sex combination (forty total). The separation of each school into two networks was necessary because the friendship question was restricted to same-sex nominations. Also, previous analyses (Coleman, 1961; Karweit, 1976) indicate that significant sex-related differences in network organization exist, suggesting that separate analyses by sex are appropriate.

Measurements of social networks which will be used in the analysis are overlap, cohesion and reachability. By the overlap of two networks we mean the number of times that a particular position(s) in one network overlap(s) with a particular position in another network. The overlap of proximity and friendship networks would, for example, indicate the number of times friends are in the same curriculum or grade.

By cohesion we mean the degree of mutuality of relationships which occurs within a network. Computationally, the cohesion measure is the ratio of the actual number of ties to the possible number of ties. For example, in a friendship network in which three persons are all involved in mutual choice relationships, the cohesion index would be 1.00 (6 actual/6 possible). If two of the three persons had mutual choices then the cohesion index would be .83 (5/6).

Another feature of networks which we will examine is reachability. Reachability, expressed as a percentage, indicates how many individuals, on average, can be linked together from any arbitrary individual. Imagine that student A has chosen 4 friends who in turn choose 4 friends and so forth. If each friend chooses persons not previously named, i.e. does not reciprocate a friendship choice, then the percentage of the total network ultimately "reached" by the initial person A, through his direct and indirect contacts, is strictly dependent upon the number of friends chosen. However, a pervasive tendency toward reciprocating choices does occur, so that in practice the true reachability is much lower than what would be obtained if no reciprocation occurred. The actual reachability indicates how "permeable" or "loose" the social structure is.

Reachability and cohesion are not the same, but are two separable measurements of networks. To clarify that this is indeed the case, consider the two networks below (adapted from Mitchell, 1969).



The cohesion in each case is the same (4/20); however, the reachability is quite different. In the network on the left person A reaches every person in the network, but no one else reaches anyone. In the network on the right, person A also eventually reaches everyone in the network but the connectivity or involvement of other members is much greater so that on the average, the reachability of the second network is appreciably greater.

Another example may further clarify the relationship between the two measurements. Coleman (1961) noted that girls were more likely to be situated in more cohesive groupings than boys. Furthermore, the girls' network of relationships exhibited greater complexity than did the boys' network. By the existence of "gatekeepers" who shared membership in two cliques, these cohesive groupings were linked together into a complex network organization. The girls' networks in this situation would be characterized by high reachability and cohesive groupings because of the workings of these gatekeepers. Reachability thus adds another dimension to the portrayal of the social structure.

We will use reachability as a measurement of the "looseness" or "permeability" of social networks in our discussions of the effects of heterogeneity of the student-body on interaction patterns. Specifically, we will examine whether increasing heterogeneity promotes greater divisiveness or, alternatively, enhances the opportunity for contact among students of differing backgrounds.

Analysis

1. The Effects of School Size

Size and Participation

Participation indicates the involvement or sense of involvement a student has in school activities and events. Is is proposed that increasing school size will decrease participation in school life due to the lessened visibility and the greater anonymity in the larger school. This relationship has been found in other studies of size effects in organizations (cf. Acton Society Trust, 1953).

Two items were used as indicators of the students' perception of visibility and importance in school life. One question asked the students (yes/no) if they thought they were a part of the leading crowd. Forming the percentage by school which responded "no" to this item, we found it correlated -.77 with school size ($p \leq .001$). Another item asked the students how far away they thought they were from running things in the school, and supplied five concentric circles for their response. The school average of this distance from the center measure correlated .69 ($p \leq .001$) with school size. These items, as indicators of visibility in school life, verify the original propositions regarding anonymity and school size.

We propose that this lessened sense of involvement will have ramifications for peer relationships within schools. Specifically, students in larger schools should name fewer persons as their friends and should be involved in less cohesive friendship groupings. We determined, for every school and sex combination, the average number

of friendship nominations made. The sociometric instrument used in the McDill survey allowed for a maximum of four choices, but did not specifically ask that four choices be given. Difficulties with "fixed response" sociometric instruments are discussed in Appendix A; we suggest that biases due to the instrument itself are not likely to be related to school size. Our procedure then entailed obtaining the zero-order correlation between school size and the average number of friendship choices. For the forty school-sex combinations, the correlation was -.315 ($p \leq .05$) which indicates that school size affects friendship network participation in the anticipated negative direction.

We also predicted that school size will affect participation in esteem networks. To gauge this, we examine the response patterns to two items: one asked the student what student in the school he would most like to be like, and the other asked the students to name someone they wished to be friends with. We expect that in larger schools, more students will leave these questions unanswered because they are unable to think of anyone within their school to nominate. For the twenty schools, the zero-order correlation between percentage non-response to the first item and school size was .52 ($p \leq .01$). The zero-order correlation for the second item was .45 ($p \leq .02$). Because non-response rates on other items did not show any relationship to school size, we interpret these higher non-response rates in larger schools as an indication that fewer students are able to think of someone within their school whom they either wish to be friends with or to be like, i.e., they have lower involvement in esteem relationships within the school.

Last, we predicted that school size will affect the operation of the proximity network--specifically, that within-grade and within-curriculum choosing will increase in larger schools because the larger grade levels and curriculum groups provide more opportunity for contact. Also, involvement in extra-curricular activities (which ameliorates the tendency for within-grade and within-curriculum choosing) is negatively associated with school size ($r = -.372$, $p \leq .07$); thus there are fewer opportunities for contacts outside curriculum and grade.

For each school the percentages of within-curriculum and within-grade friendship choices were obtained. Correlating these percentages with school size, we find that percentage of within-grade choosing is correlated -.34 ($p \leq .07$) and percentage of within-curricular choosing is correlated -.35 ($p \leq .07$) with school size. These correlations lend weak support to the opposite hypothesis, i.e. there is more within-grade and within-curriculum choosing in smaller schools. This suggests that specific attachments of any sort may well be weaker in larger schools.

Summarizing the findings, we have presented rather consistent evidence that increasing school size decreases the actual participation or sense of participation in various areas of school life. These findings of the effects of school size on participation are consistent with the view that increasing size increases anonymity and decreases visibility so that opportunities for and pressures for participation are reduced.

Size and Cohesion

Coleman (1961) observed that students in smaller schools were more likely to be involved in definite clique structures while students in larger schools were more likely to have less complicated associational patterns. Although Coleman did not speculate why size should affect the informal patterns in this way, we suggest that students in the smaller schools may simply come into contact with the same students more often, thus increasing the opportunity for friendship cliques to form.

Coleman's findings correspond to the substantial evidence in the small groups literature (for review, see Lott and Lott, 1965) that size of group and group cohesion are inversely related. In the McDill data set, as Table 1 shows, the corresponding inverse relationship holds true. Table 1 gives, for those persons naming 4 friends,

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Table 1 About Here

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3 friends, and 2 friends, the cohesiveness of the resulting friendship network. We see that (1) cohesiveness increases as the size of group decreases, in every school for both girls and boys, and (2) girls are situated in more cohesive friendship groupings than boys, and this comparison is true in every school for every size of group. These sex-related differences, which will not be discussed in any detail here, are consistent with the general notion of greater clique involvement for girls than for boys (cf. Coleman, 1961; Gordon, 1957).

Table 1

Density of Friendship Networks
Fixing Number of Friends
Named

School	BOYS 4 friends	BOYS 3 friends	BOYS 2 friends	GIRLS 4 friends	GIRLS 3 friends	GIRLS 2 friends
1	.399	.502	.641	.448	.564	.712
2	.405	.519	.619	.420	.561	.696
3	.400	.481	.537	.445	.578	.699
4	.308	.425	.533	.385	.532	.684
5	.403	.470	.556	.439	.521	.616
6	.310	.427	.540	.372	.482	.602
7	.383	.483	.571	.445	.543	.630
8	.368	.467	.560	.382	.502	.589
9	.404	.548	.694	.444	.590	.742
10	.386	.529	.640	.510	.613	.742
11	.381	.475	580	.432	.515	.610
12	.363	.486	.653	.421	.582	.727
13	.371	.485	.645	.414	.553	.716
14	.413	.515	.661	.536	.620	.742
15	.393	.465	.544	.425	.514	.592
16	.269	.483	.633	.390	.552	.686
17	.412	.501	.570	.417	.523	.603
18	.374	.451	.560	.411	.585	.723
19	.374	.528	.629	.429	.587	.734
20	.380	.486	.626	.469	.574	.711

Our primary interest is in how school size, not group size, affects the structure of the informal associations within the school. Because we know that school size affects the number of friends named (the group size) which in turn influences cohesiveness, group size must be controlled for. To accomplish this, we compute the zero-order correlation between school size and cohesiveness separately for each group size. This procedure insures that we will not be incorrectly attributing a school size effect to a group size one. Additionally, because there appear to be sex-related differences in the form of the networks, this assessment will be carried out separately by sex.

Our procedure entails computing the correlation between school size and cohesion for students naming four, three and two friends. For those naming four friends, the zero-order correlations were -.489 for girls, -.152 for boys; for those naming three friends the correlations were -.872 (girls) and -.591 (boys); for students choosing two friends the correlations were -.906 (girls) and -.692 (boys). With the exception of friendship groups of size four for boys, these results amply support the hypothesis that school size affects group cohesion, independently of its effect through group size.

A second effect of school size on cohesion focuses on the consensus of the esteem networks. We predict that students in smaller schools will be more likely to name the <u>same</u> student as the "student he would most like to be like." In smaller schools, the visibility of such a person is enhanced simply because

of the reduced number of candidates. In examining this question, we need to consider that students in smaller schools are more likely to nominate someone than in larger schools, thus any student in the larger schools has a lower probability of being chosen simply because a lower proportion of his classmates nominated anyone.

To determine if there is greater consensus on this question in smaller schools than larger schools we computed the proportion of each student body which received three or more "esteem" nominations. This proportion was adjusted by the fraction of the student body who nominated someone, and this new ratio we termed the adjusted selection ratio. If small schools have a greater proportion of their choices going to the same individuals, then the adjusted selection ratio and school size should be negatively related. For the twenty schools, the correlation was -.58 ($p \leq .01$), which supports the original proposition concerning school size and consensus in esteem networks.

Finally, we consider if the percentage of reciprocal choosing, or cohesion, within grade and curriculum is related to school size. Because students in smaller schools have a greater tendency to reciprocate choices, we must control for this fact in the present analyses. To do this, we compute the ratio of percentage of within-grade reciprocation (or within-curriculum reciprocation) to the percentage overall reciprocation and then correlate this measure with school size. We have proposed that reciprocation rates within-grade and within-curriculum will be higher in the larger schools, based on the premise that grade level and curriculum level are more efficient proximity

filters in the larger schools, defining quite concrete "social neighborhoods" within which interaction will take place. Examination of the correlation between school size and the extent of within-grade and within-curriculum reciprocation, however, indicated no relationship between the two variables ($r = .058$; $r = .039$). It appears that reciprocal social attachments in the larger schools, contrary to our supposition, are not organized around grade and curriculum lines.

2. Differentiation of students into grade and curricular levels.

Grade Level

In every school, there is a pronounced tendency for students to name same-grade students as their friends. Comparing the grade level in school for chooser and his first chosen friend, it was found that some 86 percent of the girls and 76 percent of the boys named the same-grade friends. These percentages were not altered appreciably when friendship nominations other than first friend were also examined. Moreover, these percentages were very stable across schools; that is, location in a particular school did not affect this tendency very much. For example, the number of grade levels in the school (range of values from 2 to 4) was unrelated to the percentage of same-grade choosing. Similarly, we found that school size was only weakly related to this factor. We had expected that smaller schools might have a lower percentage of within grade choosing than larger schools, which was not verified. In fact, smaller schools appear to have a higher within grade choosing pattern than do larger schools.

The most systematic variation in the extent of within grade choosing appears to be dependent upon the sex of the student. Boys, in

most schools, are less likely to name same-grade students as their friends. We cannot explore these sex differences in network characteristics in detail here; however, we can suggest a plausible explanation. Boys are engaged in a more diverse range of activities than are girls, giving them a greater opportunity for contact with students outside their grade level. Such an explanation would seem particularly germane given the emphasis on participation in athletics and the possibilities for friendship formation there. Also, boys may have a different age variation across a single grade than do girls due to differing rates of progress through school or boys may have a greater range of maturity at a given age so that friendships might tend to be less age homogeneous than for girls. For whatever reason, boys do form more grade-heterogeneous friendships than girls, but both sexes still are very likely to choose friends from within their own grade.

Curriculum Effects on Friendship Networks

Curriculum placement influences the allocation of human and material resources within schools (Heyns, 1974; Alexander and McDill, 1976). In the present study, characteristics of one's schoolmates are viewed as a potentially powerful resource. In particular, access to highly motivated peers may serve as one important source of influence for student aspirations and educational orientations.

In this section we examine the relationship of curriculum placement to friendship selection. How likely is it that a non-college preparatory student and a college preparatory student will be friends?

Do schools differ in the likelihood of same-curriculum choosing, and if so, what aspects of school life might account for these differences?

The twenty schools in the McDill sample cover a fairly wide range of percentage of students enrolled in college preparatory programs. For the girls, this percentage ranges from 33.3 to 82.1, with an average value of 53.3. Boys have a somewhat higher average, 59.6, reflecting a range of 43.3 to 83.3.

To examine the extent of within-curricular choosing, a table of the curriculum placement (college preparatory, not-college-preparatory) of chooser and his first chosen friend was obtained for each school, separately by sex. Chi-square values were computed for each school-sex combination and are given in Table 2.

Table 2 About Here

Table 2 indicates that curriculum placement is clearly an important factor in friendship selection since curriculum of chooser and chosen are significantly related in all 40 cases. Also, girls are more likely than boys to choose same-curriculum friends. And, schools are not identical in the extent of their selection of same-curriculum friendship choices. Two schools, 16 and 19, differ from the other schools for both boys and girls.

3. Rigidity of the tracking system and differential opportunities for exposure to other students.

Table 2

Curriculum Selection Chi Square and Values

Girls and Boys

GIRLS			BOYS		
School Number	Percentage College Prep.	Chi * Square	School Number	Percentage College Prep.	Chi Square
01	65.8	97.4	01	61.3	86.2
02	58.1	82.4	02	62.3	65.8
03	57.9	73.9	03	70.7	81.9
04	88.2	27.4	04	83.0	14.7
05	50.7	83.8	05	57.9	44.9
06	47.2	125.9	06	52.1	74.8
07	36.8	135.1	07	63.0	92.8
08	37.4	81.1	08	44.8	64.5
09	33.6	24.1	09	51.9	32.9
10	66.0	78.9	10	68.4	43.0
11	72.3	42.9	11	68.9	37.2
12	50.2	38.5	12	55.6	35.3
13	44.7	60.3	13	62.7	55.4
14	69.3	85.3	14	78.4	54.7
15	45.5	56.8	15	55.4	51.9
16	35.9	17.0	16	43.9	6.8
17	55.4	60.6	17	52.6	35.5
18	36.2	28.2	18	46.4	16.7
19	51.3	12.1	19	50.4	6.2
20	82.1	113.3	20	83.6	27.0

* Chi-square significant at p = .001 in all schools except 16 and 19 where p = .05.

We proposed that the rigidity of the tracking system will affect the opportunities for student contact and consequently affect the pattern of peer relations. Using principals' descriptions of the tracking systems in their schools, we examined the relationship of the tracking system to the within-curriculum choice rate and to the deviant patterns for schools 16 and 19.

Fourteen of the twenty schools grouped students homogeneously into many courses; five grouped in few courses, and one (school 3) had no homogeneous grouping. However, the differences in grouping practices were unrelated to differences in within-curriculum choice patterns. For example, schools 16 and 19 which had low within-curriculum choice rates had "few" and "many" courses with homogeneous grouping respectively. Nor were schools 16 and 19 systematically different on other tracking questions.

Examining these two schools more closely, we can speculate about their deviation. School 19 opened as a new school in the fall of 1964 with a small enrollment (433) and only two grades. Because of its newness, its small size and few grade levels, this school may not have developed the same patterns of friendship choosing that characterizes the other schools.

In school 16, the distribution of friendship choices by curriculum indicates that college preparatory students are not "over-valued" as in other schools--the college preparatory students equally distribute their choices between the two curricula, and the non-college preparatory

students are much more likely to name non-college preparatory students as friends than they are in the other schools. The specific tracking practices that we identified were not responsible for these deviating patterns. What is responsible, we speculate, is the extent to which academic endeavors are valued (or not) in this particular school.

Some support for this contention is gained by examining where school 16 is ranked in McDill's six school climate dimensions. The rank on these six factors taken together identifies school 16 as a school where a strong anti-intellectual sentiment probably exists. We propose that these prevailing climate dimensions may account, at least in part, for the observed pattern of friendship selection.

Curriculum Effects on Esteem Networks

We are proposing that just as curriculum placement affects friendship patterns, so will it affect admiration patterns and influence the distribution of responses to such queries as "who would you most like to be like?" and "who would you most like to be friends with?".

Although most status systems in high schools are decidedly non-academically oriented (Coleman, 1961, McDill and Rigsby, 1973), it is nonetheless a definite status advantage in most schools to be enrolled in a college preparatory curriculum. Consequently, one would expect to find that the majority of students nominated for these "esteem" positions will be in the college preparatory program. However, we suggest that the rate of selection of college preparatory students will vary within the school, depending upon the curriculum being considered.

To examine the role of curriculum in esteem relationships, we cross-classified the curriculum placement of the chooser and the persons nominated as the student most wanted to be like and the student most wanted to be friends with. Table 3 presents the distribution of choices by curriculum. The college preparatory students seldom

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Table 3 About Here

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select a non-college preparatory student as someone to emulate, whereas the opposite is not the case. Thus, the rate of selecting particular curriculum classmates is influenced by curriculum placement itself.[1]

4. Heterogeneity of School Composition

Schools with more heterogeneous populations offer the possibilities for friendships among a more varied set of individuals. We wish to know if the actual friendship patterns are indeed more heterogeneous. It may be the case that heterogeneity of the student body, rather than fostering such friendships, creates "boundaries" across which friendship choices are not likely to flow. The presumption of most advocates of heterogeneous schools is that increased interaction among divergent segments of the population will result, that is, friendships among a wider range of students will occur.

To examine the effect of heterogeneity of the student body on interaction patterns, we explore how reachability of friendship networks is influenced by student body composition. If increasing heterogeneity creates more riddidly defined boundaries in the school which

Table 3

Distribution of Choices by Curriculum

	Chooser Not CP		Chooser CP	
	Chosen		Chosen	
	Not CP	CP	Not CP	CP
Best Student	1203	4474	512	8380
	.212	.788	.058	.942
Like to be like	3149	2691	1257	7378
	.539	.461	.146	.854
Wish to befriend	2068	2256	1385	5538
	.478	.522	.200	.800

constrain friendship choices, then heterogeneity and reachibility should be inversely related.

We measured the heterogeneity of the school as the variance of the educational expectations of the school. The selection of this variable was somewhat arbitrary; other variables such as background characteristics or ability characteristics could perhaps have just as well been used. The reachability of each school was computed by an adaptation of a tracing algorithm presented by Rapaport and Horvath (1961) and Fararo and Sunshine (1964). Details of the tracing algorithm are supplied in Appendix B. Tables 4 and 5 show the reachability and other pertinent school variables for girls and boys.

Tables 4 and 5 About Here

The percentage reached in a network is necessarily related to its contact rate, in our case the average number of friendship choices per school.[2] Consequently, in these analyses we control for the contact rate. Regressing percentage reached on the heterogeneity of the school and the contact rate, we find that heterogeneity is of minor importance in explaining the percentage reached for girls ($t = 1.36$), but is of some consequence for boys ($t = 2.11$). The equations used and the standardized and raw coefficients obtained are given below.

Table 4

Network Organization Variables - Boys

School Number	Percent Reached	Number of Steps	School Size	Heter	Density	Contact Rate
01	.733	21	209	2.37	.399	3.07
02	.738	18	420	2.19	.405	3.05
03	.731	22	519	2.18	.400	3.01
04	.730	17	488	1.98	.308	2.54
05	.826	18	710	2.12	.403	3.16
06	.343	41	921	2.18	.310	2.19
07	.743	21	525	2.32	.383	2.85
08	.776	20	1046	2.09	.368	3.01
09	.846	20	214	2.16	.404	3.29
10	.802	14	257	2.20	.386	3.20
11	.826	19	946	2.01	.381	3.14
12	.486	21	302	2.26	.363	2.91
13	.755	34	477	2.18	.371	2.82
14	.842	20	321	2.12	.413	3.07
15	.733	18	577	2.25	.893	3.12
16	.797	19	453	2.13	.269	3.16
17	.781	28	823	1.99	.412	2.97
18	.749	22	482	1.62	.374	2.89
19	.595	26	233	2.25	.374	3.01
20	.771	23	419	2.14	.380	2.95

Table 5

Network Organization Variables - Girls

School Number	Percent Reached	Number of Steps	School Size	Heter	Density	Contact Rate
01	.912	22	219	2.17	.448	3.38
02	.859	19	399	2.05	.420	3.38
03	.792	22	466	2.05	.445	3.26
04	.712	24	466	1.60	.335	2.97
05	.870	27	662	1.89	.439	3.35
06	.760	24	927	2.07	.372	2.82
07	.846	20	521	1.99	.455	2.98
08	.866	19	1080	2.08	.382	3.15
09	.902	17	216	1.93	.444	3.36
10	.861	23	260	2.09	.510	3.30
11	.871	21	921	1.48	.432	3.33
12	.781	29	270	2.16	.421	3.23
13	.882	20	465	2.19	.414	3.23
14	.628	28	305	1.80	.536	3.44
15	.861	21	633	2.09	.425	3.36
16	.910	17	451	1.82	.390	3.38
17	.901	20	767	1.83	.417	3.33
18	.882	20	331	1.87	.411	3.23
19	.683	26	200	1.71	.429	3.13
20	.848	26	441	1.82	.469	3.48

(BOYS)

$$PCTRCH = a + b_1\ CONTACT + b_2\ HETER$$

$$= .123 + .382\ CONTACT - .246\ HETER$$
$$(.761) \qquad -(.315) \qquad \text{(standardized betas)}$$

$R^2 = .625 \qquad t = 5.10 \qquad t = 2.11$

(GIRLS)

$$PCTRCH = a + b_1\ CONTACT + b_2\ HETER$$

$$= .065 + .164\ CONTACT - .121\ HETER$$
$$(.348) \qquad (.294) \qquad \text{(standardized betas)}$$

$R^2 = .201 \qquad t = 1.61 \qquad t = 1.36$

For the boys, the contact rate and the heterogeneity explain about 63 percent of the variance in percent reachable. The contact rate positively affects the percent reachable while the heterogeneity depresses the reachability. For the girls, neither the contact rate nor the heterogeneity is a significant factor in explaining the observed percent reachable. This lack of an effect for school heterogeneity for girls is consistent with Alexander and Eckland's (1974) argument that school composition does not affect peer relationships for girls as strongly as it does for boys. Another set of regressions was conducted to examine the relationship of reachability and cohesion of friendship groups. The percent reachable for girls is negatively correlated to the cohesion of the friendship group, a relationship which does not disappear once the contact rate is controlled. Regressing percent reachable on contact rate and density, the standardized (raw) coefficients are .65 (.30) for contact rate and -.57 (-1.1) for cohesion with associated standard errors of .11 and .46. For girls,

density and contact rate taken together are important factors in explaining their reachability. This supports the view that girls have cohesive groups but still attain a high percent reachable by the operation of "gatekeepers" who bridge the gap between the tightly drawn cliques. Choices "escape" to other cliques through these gatekeepers, thus providing a high degree of reachability or connectivity.

Boys, on the other hand, follow a different model. The positive correlation between density and percent reachable disappears once the contact rate is introduced. For the boys, the standardized (raw) coefficients for contact rate and density are .71 (.36) and .03 (.11) with standard errors of .10 and .63. The boys' network structure is dependent upon the initial contact rate, with little help from the density. Their friendship networks appear to be relatively simple in structure, without the complicated intertwining clique structure found in the girls' networks.

A final issue concerns the effect of heterogeneity on esteem relationships. Do students in more heterogeneous schools select a more heterogeneous group of students as ones they admire? To answer this, we cross-classified the college plans of the chooser and the plans of the person selected as someone he would like to be like for each school and sex. Next, the ratio of chosens who had definite college plans to choosers who had definite college plans was formed. A value larger than 1.0 indicates that in that school the persons with college plans were over-selected. Not surprisingly, the ratio exceeded 1.0 in all schools. We then determined how this ratio varied with the

heterogeneity of the school population. If heterogeneity produces increased opportunities for esteem relationships among diverse students, then the variance and the selection index will be negatively related. This was not the case, as the zero-order correlations obtained were .229 for the girls and .398 for the boys. These results suggest that increasing heterogeneity does not increase the heterogeneity of the esteem relationships.

Summary and Discussion

This paper has explored how school organizational properties influence interaction patterns of students. The size of the school, its differentiation practices, and its student-body composition were specific organizational features of the school which were considered. The informal arrangement of students in schools was viewed as a network of relationships, and characteristics of these networks were examined with respect to school organizational features. We found that school size depresses participation in and cohesion of friendship and esteem networks. These effects for school size were explained by the increasing anonymity and decreasing visibility for students in larger schools.

We next considered how differentiation practices, namely the sorting of students into grade levels and curriculum levels, affected the interaction patterns. Arguing that these differentiation practices affected the proximity networks or contact networks, we then examined the overlap between the proximity and friendship and esteem networks.

The organization of schools into grade levels greatly influenced who would become friends with whom, as did the sorting by curriculum. The schools were much the same in the extent of same-grade choosing, although there was a slightly greater tendency for this pattern in the smaller schools. Same-curriculum choosing was a pronounced trend except in two schools. One of these schools was a new school in which the usual pattern of relationships may not have had an opportunity to evolve. In the other school, a prevailing anti-academic orientation may have resulted in the observed choice pattern.

Finally, we considered how the heterogeneity of the student body was related to various features of the networks. Here we found strong evidence that the heterogeneity of the school has quite different effects on network properties for girls and for boys. The connectedness or reachability of the boys' friendship network, but not the girls', was negatively affected by the heterogeneity of the school. Concerning the effect of school heterogeneity on esteem networks, we did not find that increasing heterogeneity increased the variability of the attributes of persons nominated. That is, we did not find more heterogeneous esteem choices in more heterogeneously composed schools.

In conclusion, we propose that the network approach offers a useful framework for studying how organizational features and informal interactions are related. By providing a language and procedures for focusing on the overlapping of relationships, the network approach facilitates the task of analyzing multiple relationships within an organizational context.

Footnotes

1. This finding calls into question the assumption that a single reference group, operationalized by a school average, can reasonably be used in studying the influence process within a school. It appears that the notion of multiple reference groups could profitably be incorporated in school process models.

2. This fact is easy to see by the following example. Assume that reciprocation of choices does not occur, then for any school the number of persons ultimately connected together is strictly dependent upon the number of friends named by each new contact.

3. The fifteen variables used were: Father's education, Curriculum, Academic Values, Evaluation of time spent in school, Educational Expectations, Academic Self-Image, Ability, Grades, Status in School, Mother's Education, Number of books in the home, Number of siblings, Grade in School, and Mathematics Achievement Score.

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Appendix A

DATA AND VARIABLE DESCRIPTION

The items from the McDill Twenty High School Data which will be used in the paper are described below.

1. Size of school

   The number of students for whom a questionnaire was obtained.

   This variable ranges from 233 to 2127.

2. Grade in school

   Based on the student response to the question:

   "In what grade are you? (check one).

   1. 9th grade
   2. 10th grade
   3. 11th grade
   4. 12th grade

3. Curriculum

   Based on the student response to the question:

   "What program are you taking in school (check one).

   1. not yet decided
   2. vocational
   3. commercial or business
   4. general
   5. college preparatory
   6. other (what?_____)

4. Educational Expectations

   This index of educational plans is based on responses to the following three questions.

   1. Are you planning to finish high school?
      a. Yes
      b. No
      c. Undecided

2. Are you planning to attend college?
   a. No, never
   b. Yes, but not right after high school
   c. Yes, as a full-time student right after high school
   d. Yes, as a part-time student right after high school.
   e. Undecided.

3. Check the highest level of education you expect to complete.
   a. Plan to attend a two-year college
   b. Plan to get a bachelor's degree
   c. Plan to do one year of graduate study (Master's Degree)
   d. Plan to obtain a professional degree
   e. Plan to obtain a Doctoral Degree
   f. I have not made a decision about my plans.

Scores on this index, obtained by combining responses to the three items, vary from 1 (no definite commitment to finishing high school) to 8 (plans to obtain the Ph.D.)

5. Friendship Choices

The students were asked: "of the boys (girls) in this school who do you go around with most?" Four lines were left for their nominations and these nominations were termed

"friendship choices." Because the nature of this question may influence the responses obtained, a discussion of measurement error in sociometry, relevant to this survey, is now provided.

Until recently, the information derived from sociometric instruments was accepted as having "face validity"; that is, the instrument itself was not seen as introducing particular measurement biases. However, Holland and Leinhardt (1972), Hallinan (1974) and Smith (1975) have pointed out the naivety of this assumption in their discussions of the sources and consequences of measurement error in sociometry. With respect to the fixed-choice instrument (" name your three closest friends"), of which the McDill item is a variant, Holland and Leinhardt discuss three possible response situations: (1) the respondent could have exactly the number of friends requested, 2) the respondent could have fewer friends, but would name more to conform to the question and, 3) the respondent could have more friends, but would name less to conform to the question. Situations 2 and 3 would then lead to error in measuring the social structure; in situation 2 by creating friendship ties where none were, and in situation 3 by dropping ties which were actually present.

In tables 4 and 5, the average number of choices per school (contact rate) was given. From the extent of variation on this variable, it is suggested that students did not feel constrained to fill up the space, that is to name exactly four friends (situation 2).

Next, considering situation 3, there is no way to unequivocally assess the effect of missing data. We can explore the seriousness of the truncation problem by determining if the pattern of correlations among friends differs according to the order in which the friend is named. If the chooser and his first friend and the chooser and his fourth friend are equally alike, this would suggest that loss of the fifth and other friends would not be too serious. Examining the correlations for the chooser and his 1st,2nd,3rd and 4th named friends on 15 attributes indicated that the order of the friendship choice was unimportant in the degree of similarity between chooser and chosen. By using each correlation on these 15 attributes as a data point, we obtained the correlation among the correlations which are displayed in table A-1. This table suggests that if space had been allowed for recording five or more choices, the pattern of correlations may have been similar. Of course, the effect of missing data remains unknown.

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Table A-1 About Here

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6. Esteem choices

   a. The students were asked:

      "Thinking of all the boys (girls) in this school, who would you most want to be like? (Give both first and last name)."

Table A. 1

Correlation of Correlations

Between Chooser and Chosen*

	Self and First	Self and Second	Self and Third	Self and Fourth
Self and First	-	.987	.994	.996
Self and Second	.993	-	.996	.995
Self and Third	.993	.994	-	.994
Self and Fourth	.993	.995	.996	-

* Girls are above the diagonal, correlations for boys are below the diagonal.

b. Another question asked:

"of all the boys (girls) in your grade which boy (girl) ...

(Give both first and last names).

... is the best student _____

... would you most like to be

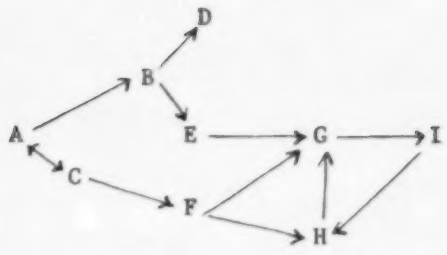
friends with _____

Appendix B

Tracing Algorithm for Estimating Reachability

The ultimate connectedness of any social choice data can be obtained by suitable manipulation of the choice matrix. Procedures for so doing are available in Coleman (1964) and Fararo (1973). However, when the sociomatrix is large the amount of computer resources entailed may be overwhelming. If one is interested basically in the final reachability, then a satisfactory estimation of that can be obtained by sampling individuals in the population, tracing their social choices throughout and continuing this procedure with new individuals until the process appears to converge. This tracing procedure has been elaborated elsewhere (Rapaport and Horvath, 1961 and Fararo and Sunshine, 1964). For the present paper, we followed their procedure, writing a computer program to carry out the tracing.

Pictured below is a network of 9 individuals, call them A-I. The social choice relations among them are depicted by single-headed arrows (one-way choice) or double-headed arrows (mutual choice). The tracing algorithm will randomly select an individual and follow or trace his choices throughout the network. His first choice and the behavior of the network at that instant is termed time step one. The behavior in terms of friends of friends is depicted at time step 2, and so on until all the indirect ties in the network are traced out. For the purpose of explanation, a tracing is performed on the sample network.



t	N(t)	X(t)	P(t)
1	2	2	.182
2	3	5	.455
3	2	7	.636
4	2	9	.818
5	2	11	1.000
6	0	11	1.000

Individual A, designated the starter, picks two friends, B and C, so the number of new individuals added at time-step 1 is two. B picks D and E, who were not previously named, so B adds two net contacts at this time step. Individual C reciprocates a choice with A, and picks one new person, F. Thus, the total number of new individuals added at time-step 2 is three. The process continues until no new individuals are added. In the table beneath the figure, X(t) refers to the cumulative number added and P(t) to the cumulative proportion of the total.

The entire tracing procedure is repeated with enough starters to lend stable estimates to the percent reachable estimates [the P(t)]. This is usually done by testing to

see if a new starter changed the average value by more than some arbitrary constant, e.g. .0001. The statistics then provide estimates of the contact structure of the observed network.